CHAPTER 4. BANANA RIVER LAGOON

Seagrass and Water Quality

Seagrass Resource Assessment

The status assessment of Banana River Lagoon's seagrass resource is based largely on the same measurement indices used in the Lagoon-wide and other sub-lagoon assessments. These indices are:

- ❖ Acres of seagrass coverage over time (net gain or loss),
- ❖ Maximum depth of the edge of seagrass beds, and
- ❖ Percent of photosynthetically active sunlight at the target depth of 1.7 m.

For more information on why and how these measurement indices are used to assess the status of the seagrass resource, refer to Chapter 2, p. 2-3. Major findings about the status of the seagrass resource in Banana River Lagoon are summarized below.

- Banana River Lagoon exhibited stable seagrass coverage throughout the 1990s; even showing remarkable improvement in 1999 (Figure 4-1a and b).
- The north segment of the lagoon (BR1-2) is classified as good (Table 4-1) and is one of the better seagrass resource segments in the IRL system. The north segment is located within minimally developed watersheds, and its bottomland is federally protected, managed by the U.S. Fish and Wildlife Service. Close behind in status is the central segment (BR3-5), also classified as good (Table 4-1). Both segments have experienced little loss of seagrass since 1943 and have, in recent years, reached or exceeded 1943 acreage levels (Figure 4-1a and b).
- The north and central segments (BR1-2 and BR3-5) have good to excellent seagrass coverage because the deep edge of seagrass is close to the potential target depth (Figure 4-1d). The target depth of 1.7 m is not fully attained probably because the sub-surface light level at that depth falls short of the preliminary minimum '25%' requirement (BR1-2 and BR3-5 each receive 18% of surface light at 1.7 m; BR6 and BR7 receive 14% and 15%, respectively; see Figure 4-1c).
- The worst segment in Banana River Lagoon is the Newfound Harbor/Sykes Creek area (BR6). Not far behind is the south segment (BR7). Both segments are classified as poor (Table 4-1). In both segments, seagrass acreage has diminished more than 50% between 1943 and 1996. Also, the sub-surface light and seagrass depth indices are lower in these two segments than in the north and central segments (Figure 4-1c and d). However, despite their poor status, both segments (BR6 and BR7) showed dramatic gains in seagrass coverage in 1999 (Figure 4-1b).
- In Banana River Lagoon, a notable shift in seagrass species occurred in the latter half of the 1990s. The abundance of *Syringodium filiforme* decreased while *Ruppia maritima* became more abundant (SJRWMD data; Provancha and Scheidt, 2000). *Ruppia* is more tolerant of low salinity, and *Syringodium* is the least tolerant of the species found in this Lagoon[1]. The species shift was observed during a time of low

[1] Four species of seagrass are found in Banana River Lagoon: *Halodule wrightii, Syringodium filiforme, Ruppia maritima*, and *Halophila engelmannii*.

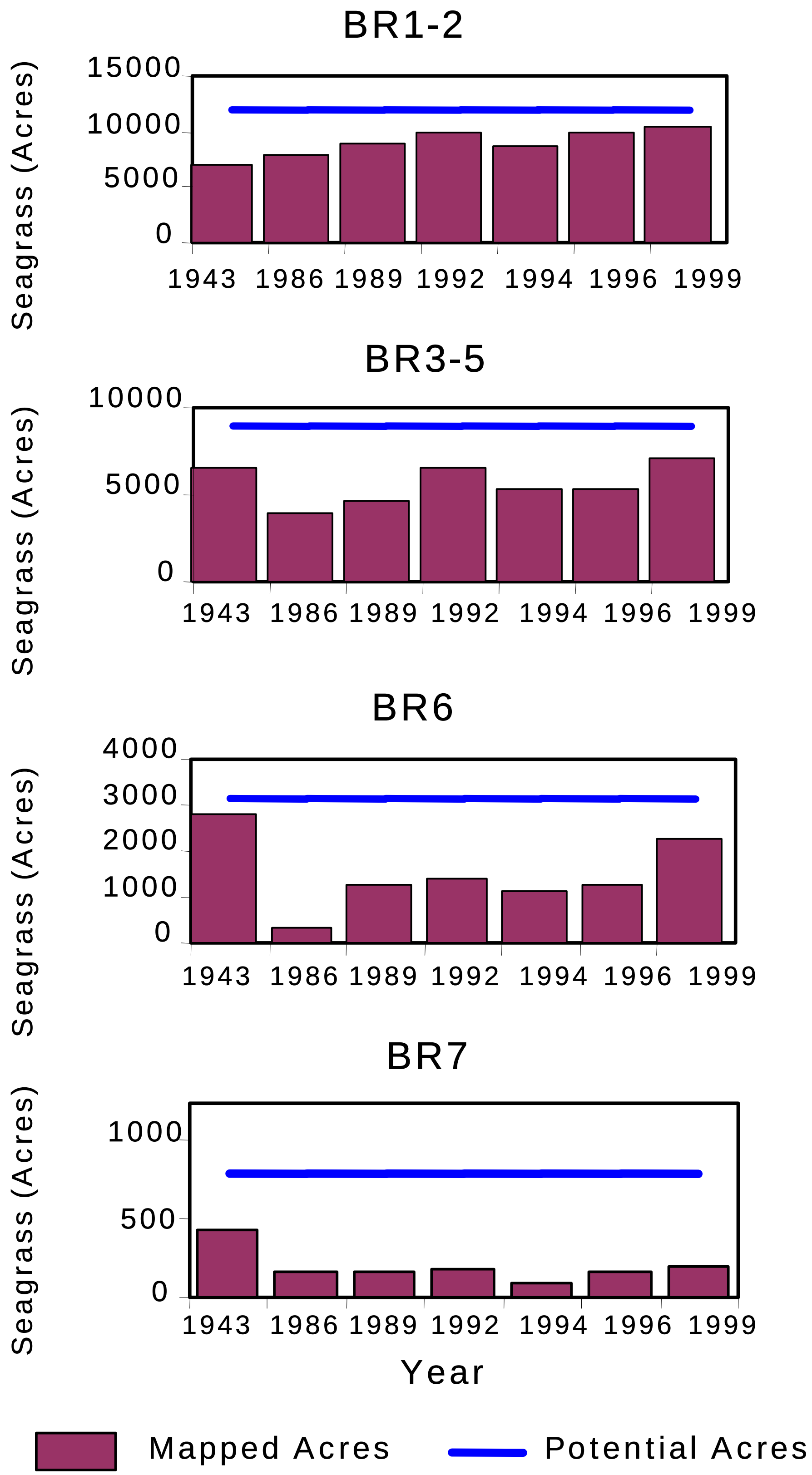

Figure 4-1 b. Acres of seagrass, by segment, in each year mapped. Note differing scales. Potential seagrass acres (the area < 1.7 m deep) are shown as a blue line. Note general long-term stability in segments BR1-2 and BR3-5 and a pattern of recovery from 1994 to 1999 in all segments.

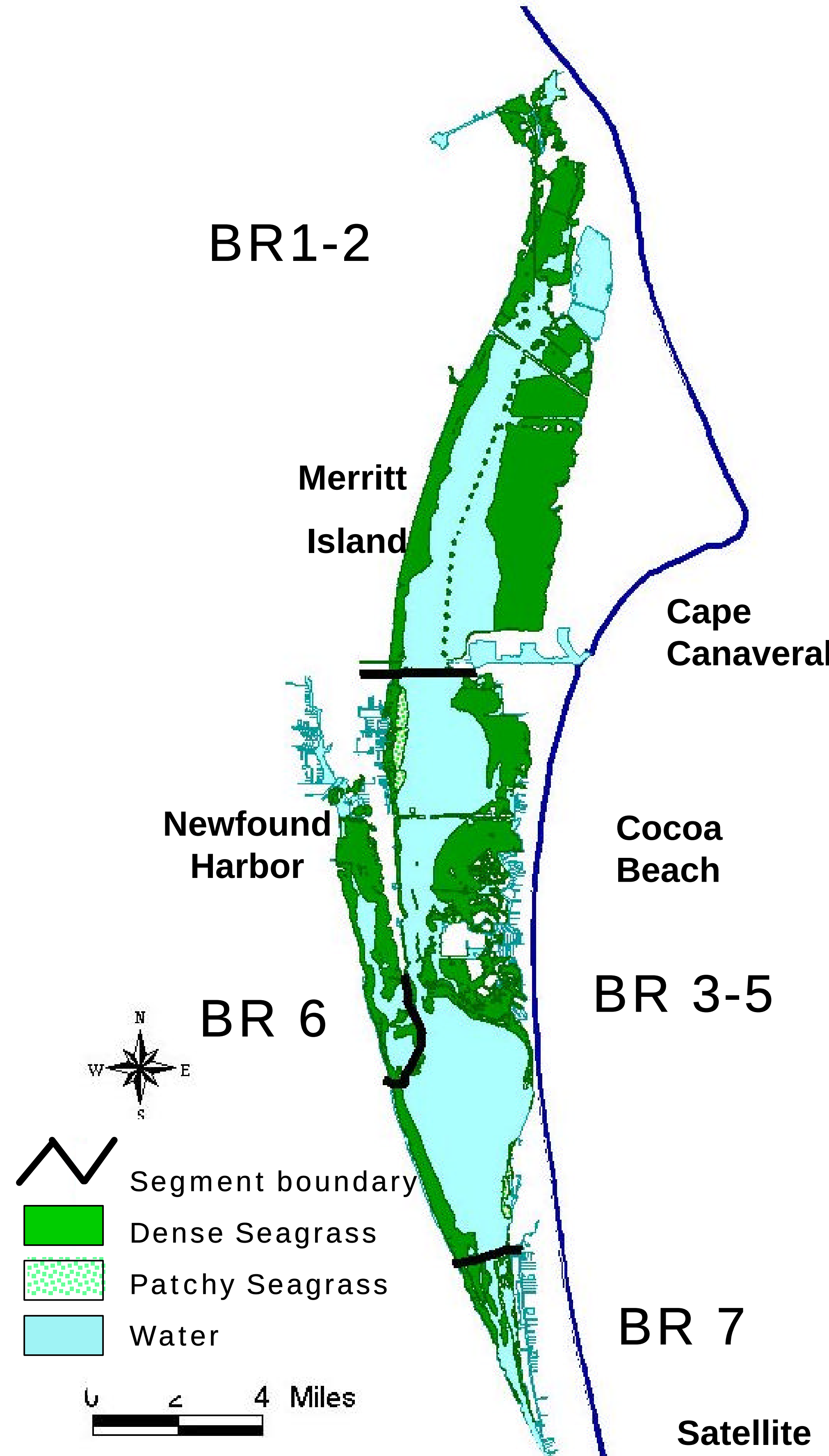

Figure 4-1a. Banana River Lagoon 1999 seagrass coverage and segment boundaries

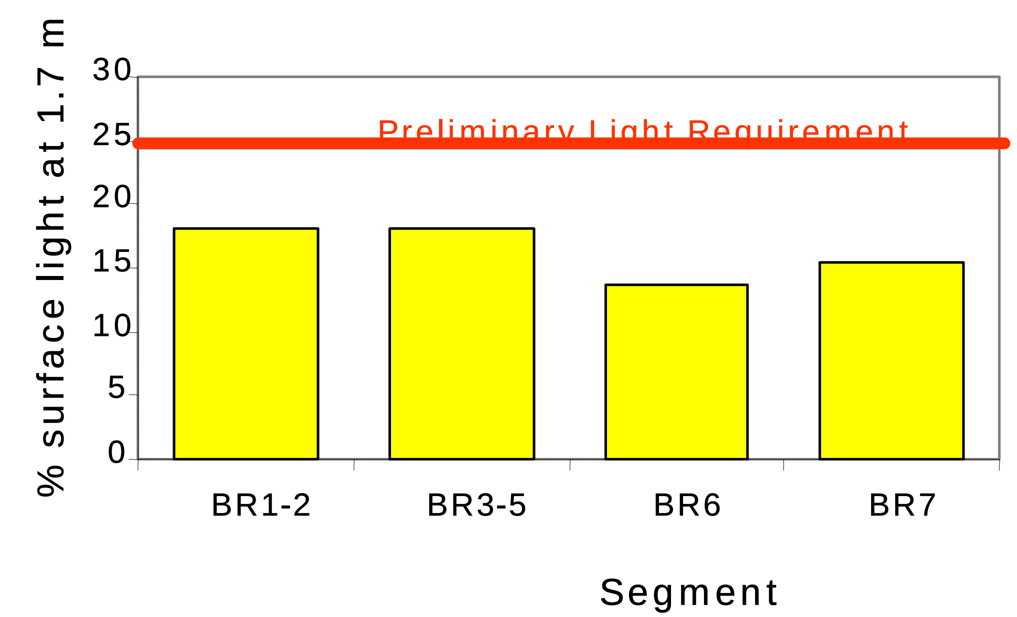

Figure 4-1 c. Median percent surface light at the 1.7-m target depth for each segment, north to south (see map at left for location of segments). Based on monthly measurements from 1990 to 1999.

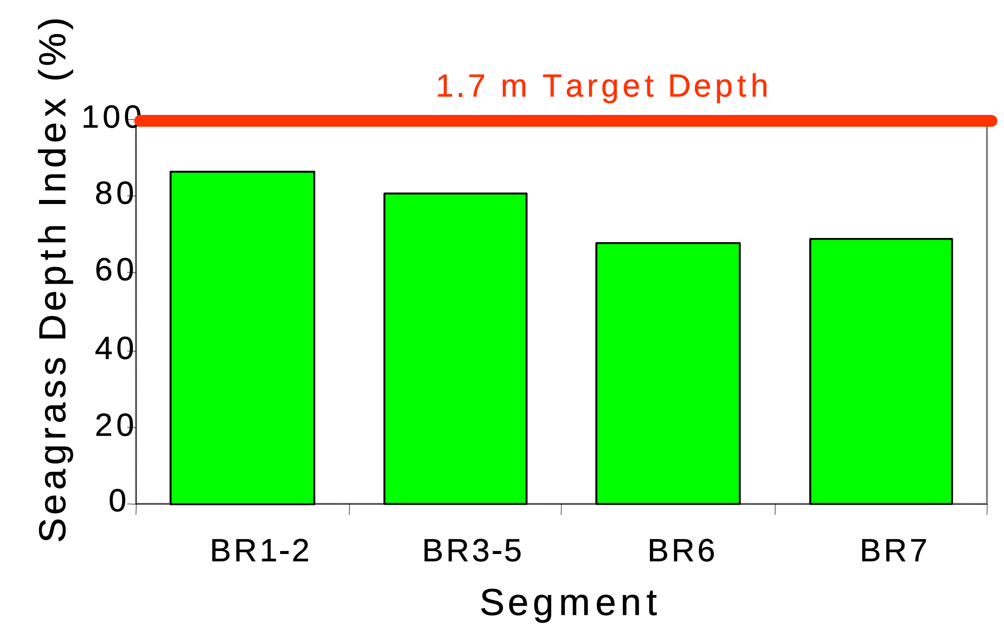

Figure 4-1 d. Average Seagrass Depth Index = depth of edge of bed as a percent of the 1.7-m target depth*. Based on average seagrass deep edges mapped in 1992, 1994, and 1996.

* The Seagrass Depth Index (SDI) is based on potential coverage to 1.7 m referenced to the NAVD88 vertical datum. The SDI would be slightly less if potential coverage were referenced to mean water level (MWL).

salinity (annual means <20 ppt). This phenomenon is discussed further in the water quality assessment section below.

Table 4-1. General classification of Banana River Lagoon segments – Good, Fair or Poor

Banana R. Lagoon Segments	= 20% surface light @ 1.7 m	SDI = 75%	loss since '43 = 50%	loss since '43 = 75%	Classification
BR1-2	X				Good
BR3-5	X				Good
BR6	X	X	X		Poor
BR7	X	X	X		Poor

Classification is based on the following indices criteria: % surface light @ 1.7 m (see Figure 4-1c), seagrass depth index (SDI; see Figure 4-1d), and % loss of seagrass since 1943: = 50% and = 75%.
Any segment receiving 3 or more marks is classified as poor, 2 marks fair, 1 mark or less good.

The Banana River Lagoon segments are fairly shallow (2 m average depth) and the most poorly flushed in the IRL system. It is estimated that it takes nearly 2 years for a complete turnover of water volume to occur throughout this Lagoon (SJRWMD's unpublished PLR Model results)[2]. Because it is shallow and poorly flushed, Banana River Lagoon may be quite susceptible to harm from pollutant loading. This susceptibility is probably best demonstrated in Newfound Harbor (BR6) and the south segment (BR7) where substantial seagrass loss has occurred in contrast to more stable seagrass coverage observed in the north and central segments. There are a few possible factors that may explain why this is the case.

-- The north segment (BR1-2) is largely undeveloped, and human activities are restricted (for example, the area is a powerboat exclusion zone).

-- The central segment (BR3-5), although developed, has a relatively small watershed and low runoff volume relative to its large receiving water volume.

-- Wind-forced circulation in these large open segments may play a more significant role in dispersing pollutants and reducing the build-up of organic material and muck sediments than is the case in the smaller, more confined areas of Newfound Harbor (BR6) and the south segment (BR7).

-- The central segment is host to a large abundance of drift macroalgae (4 to 100 times the drift algae biomass found in the other segments, 1997 - 1999, SJRWMD data). Macroalgae function well as a nutrient "sponge" (Davis et al., 1983), thus helping to limit populations of phytoplankton. As a result, the negative impact of phytoplankton as an "optical pollutant", with its attendant effect on seagrass, is minimized.

[2] The Port Canaveral lock system provides only a very minor, intermittent connection between the ocean and Lagoon. Its effect on flushing or hydrodynamics overall in the Banana River Lagoon is considered insignificant.

Water Quality Assessment

The factors listed in the previous section that may help explain why the Banana River Lagoon's north and central segments (BR1-2 and BR3-5) have better seagrass coverage than the Newfound Harbor and south segments (BR6 and BR7) are only marginally reflected in the water quality. Newfound Harbor (BR6) has appreciably higher median color and chlorophyll *a* concentrations than the better segments. The south segment's color and chlorophyll *a* levels are just slightly higher[3]. Otherwise, there are no major differences in the levels of other optical pollutants among the Banana River Lagoon segments.

Statistically, chlorophyll *a* and turbidity/TSS are the primary pollutants, followed by color, that affect light penetration in Banana River Lagoon. Temporal trends for these constituents and nutrients show general stability for most of the Banana River Lagoon through most of the 1990s (Figure 4-2a and b). However, in the north segment, both chlorophyll *a* and color levels recently increased (Figure 4-2a and b, BR1-2), exceeding concentrations in other Banana River Lagoon segments. This downward trend in the north segment is interesting (and hopefully short-lived), given the fact that the poorer segments in Banana River Lagoon are showing some improvement.

The salinity trend in Banana River Lagoon is probably the major story for this lagoon. Salinity levels dropped precipitously in 1995, following heavy rains, and remained low for several years (Figure 4-2a). The lowest sustained salinity levels were measured in the south segment (BR7), commensurate with low levels measured in the contiguous waters of the Indian River near Melbourne (Figure 4-3).

Because Banana River Lagoon is poorly flushed, prolonged salinity drops following or during heavy rainfall can be expected. Annual average rainfall from 1989 through 1994 was just under 48 inches; but from 1995 through 1999, the annual average was 60 inches (National Weather Service, Melbourne Airport). Salinity levels responded in kind, dropping and remaining below 20 ppt from 1995 through 1998 (Figure 4-4). This salinity drop may explain the decline in *Syringodium* coverage and the corresponding increase in *Ruppia*, a species more tolerant of low salinity than other Lagoon seagrasses. Salinity below 20 ppt restricts the growth of most seagrass species found in Banana River Lagoon (except *Ruppia*) (Reid, 1954; Voss & Voss, 1954; Humm, 1956). It is possible that the prolonged period of low salinity may have offset the benefits of any water quality improvements observed in the poor segments (BR6 and BR7), lessening the potential for seagrass expansion. Then, in 1999, salinity increased, fluctuating around 20 ppt. This rebound in salinity along with the water quality improvements may have enabled seagrass coverage to expand that year (Figure 4-1b).

Summary of Assessments

Moderate, but apparently crucial differences in water quality (especially color and chlorophyll a) and sub-surface light conditions exist between Banana River Lagoon's *good* seagrass segments, north and central, and the *poor* segments in Newfound Harbor and the extreme southern end. From 1997 through 1999, the margin of difference

[3] 10-year medians of color and chlorophyll *a*: *BR 1-2*: 16 pcu and 5 µg/l; *BR 3-5*: 17 pcu and 7 µg/l
BR 6: 25 pcu and 12 µg/l; *BR 7*: 19 pcu and 7.5 µg/l

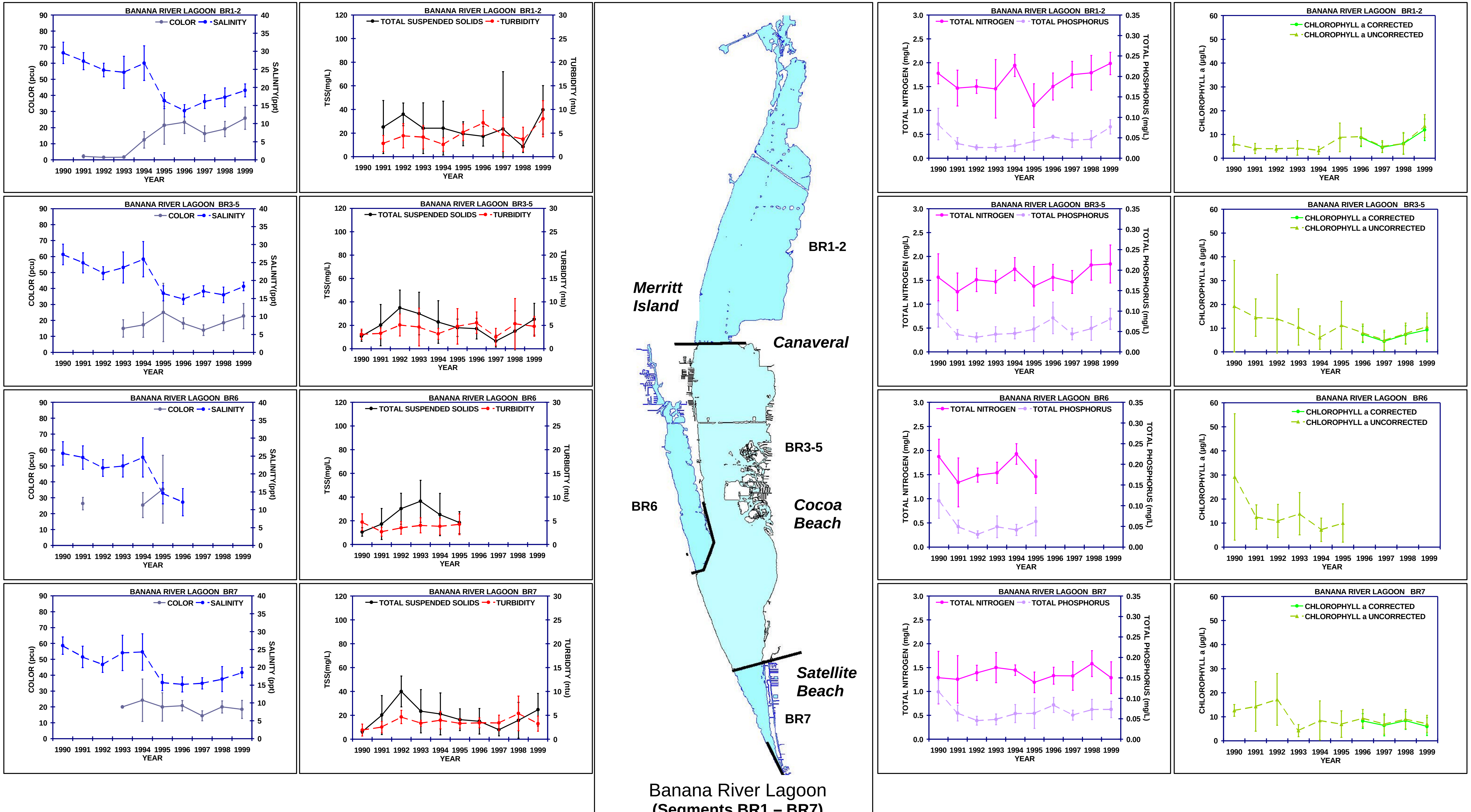

Figure 4-2. Temporal Distribution of Color, Salinity, TSS, Turbidity, Total Phosphorus, Total Nitrogen, and Chlorophyll *a* in the Banana River Lagoon ($\bar{x}$± 1sd, 1990-1999 period of record).

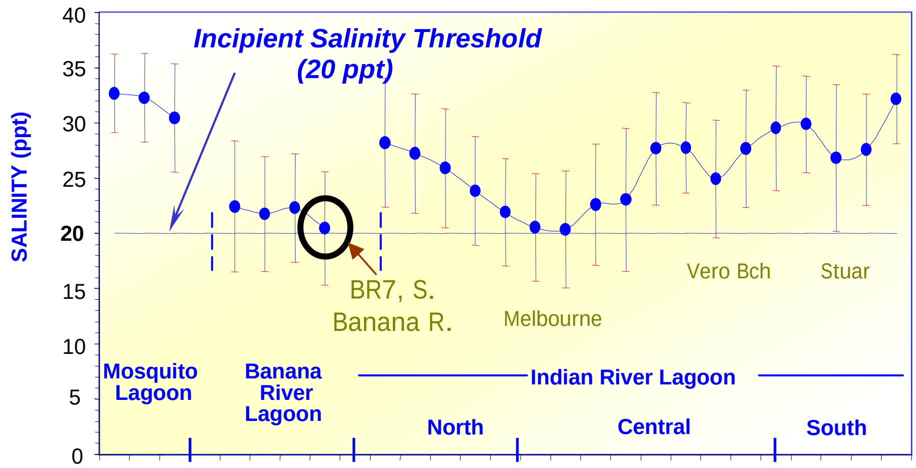

Figure 4-3. North to south distribution of salinity levels in the IRL system (means +/- S.D., 1990 – 1999)

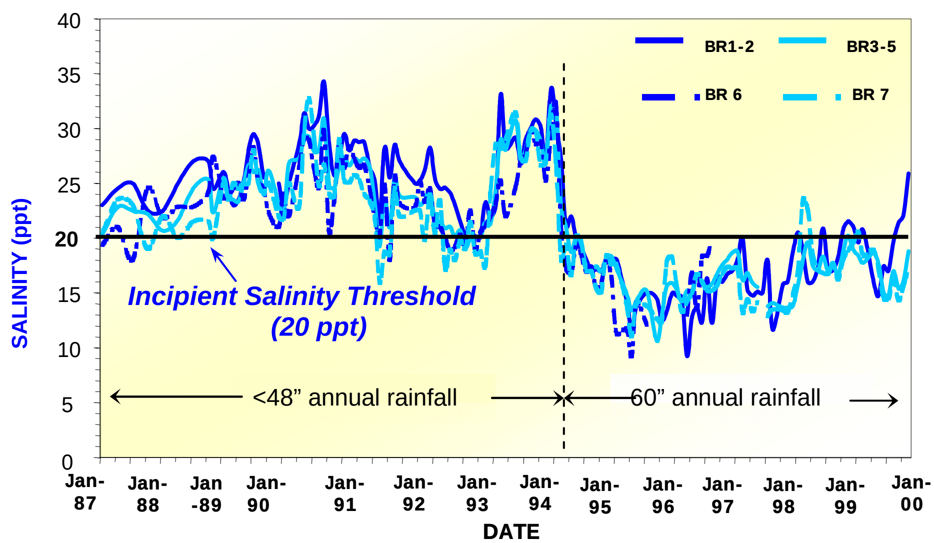

Figure 4-4. Monthly salinity levels from 1987 - 2000 in the Banana River Lagoon

between the good and poor segments closed even further; the result of a small decline in water quality in the good segments as well as a small degree of water quality improvement in the poor segments. But, any potential gains in seagrass coverage in the poor segments could have been stymied by low salinity (<20 ppt) from 1995 through 1998. In 1999 salinity slightly increased as did seagrass coverage.

The seagrass and water quality trends observed in Banana River Lagoon during the 1990s highlight the fact that optical pollutants and water clarity aren't all that need to be understood and addressed to manage seagrass. Other processes that affect salinity and nutrient dynamics – rainfall/evaporation, groundwater discharge rates, and macroalgae densities – may be more important in this semi-enclosed Lagoon than in the more open and better flushed segments of the IRL system. These processes should be examined more closely in the development of PLRGs in Banana River Lagoon.

Progress on Projects

Strategies for Pollutant Load Reduction. Volume reduction and water quality treatment of non-point surface water drainage are the key elements of the pollution abatement strategy in Banana River Lagoon. Since 1943, the non-point loadings of nutrients and suspended solids have doubled (Figure 4-5). A substantial portion of that increase originates in the central and southern segments of Banana River Lagoon (BR3-7 segments, Figure 4-5). Consequently, these same segments are receiving assistance from the SJRWMD and IRLNEP to plan and construct drainage treatment projects for both storm and non-storm drainage.

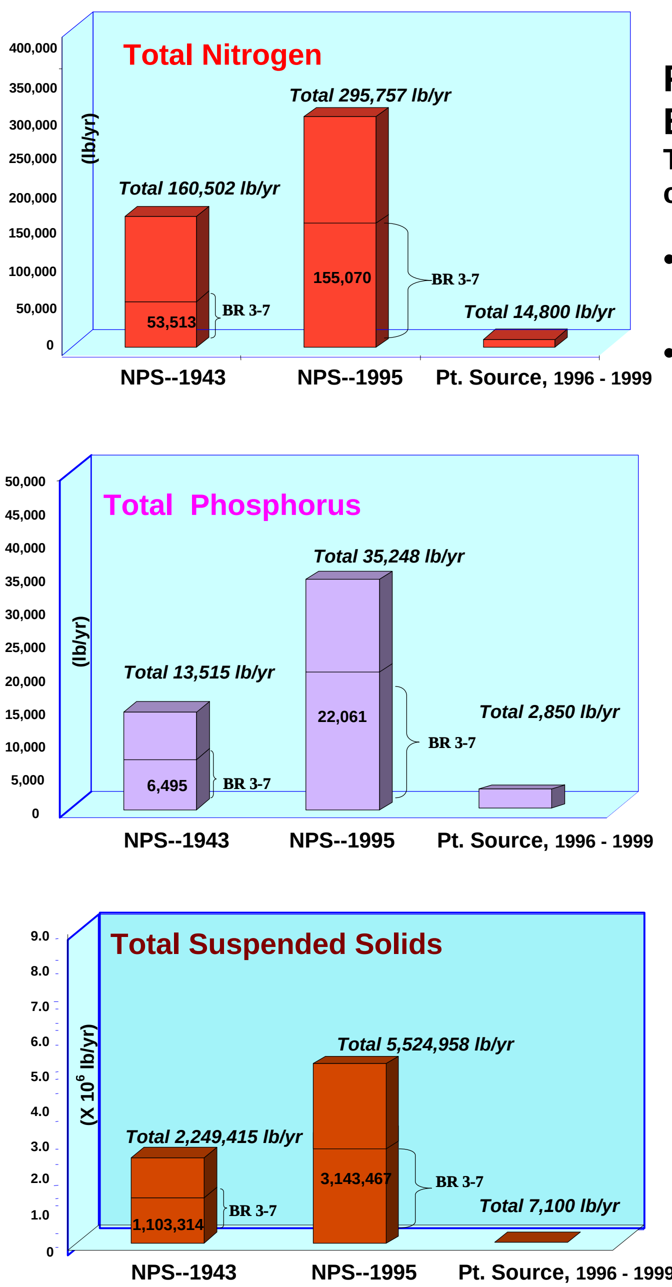

Figure 4-5.
Banana River Lagoon
TN, TP and TSS loading comparisons:

- **1943 vs 1995 Non-point source (NPS) run-off loadings***
- **1995 NPS vs annual point source or domestic WWTP loadings.**

Þ The 1943 loading estimates are adopted as provisional PLRGs; intended for planning purposes only.

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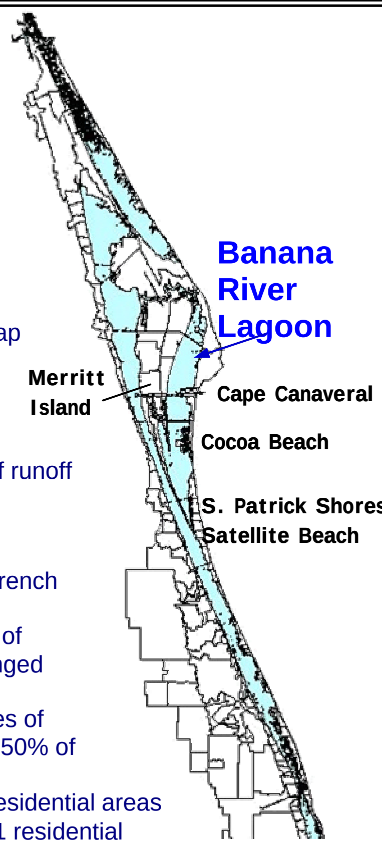
*NPS loading estimates derived from SJRWMD's IRL-specific Pollutant Load Screening Model (PLSM). Loadings do not include atmospheric and groundwater inputs. Point source loadings are from domestic WWTPs derived from FDEP records.

Non-point Source Strategy – Surface Water Drainage. Plans for the quantity and quality treatment of urban drainage are either completed or nearing completion for the major population centers that stretch along the barrier island: the cities of Cape Canaveral, Cocoa Beach, and Satellite Beach. Concurrent with their planning, the cities have proceeded with several, small-scale treatment projects when the funding was available. For example, over the last 6 years the SJRWMD's IRL program provided cost-share support to county and city projects, most of which primarily handle soil and debris removal from drainage systems that serve less than 25 acres of moderate to high density residential development (Table 4-2).

Table 4-2. Non-point, surface water treatment projects in the Banana River Lagoon basin supported by SJRWMD and local government cost-share funds, 1995 - 2001

- Merritt Island (Brevard County) -- Merritt Island airport detention pond serving a 190-acre residential basin with nutrient & TSS removal efficiency of ~ 50% for storms up to 1".
- Merritt Island (Brevard County) -- Trash collection traps (a.k.a. curb/grate inlet baskets) installed in storm drains throughout Merritt Island. Some include oil absorbance pillows.
- South Patrick Shores -- *Thrush St.* baffle box serving about 2.4 acres of residential land (1,608 lb of sediment removed in 9 months)
- City of Cape Canaveral – a CDS/Vortech™ sediment trap serving the city's WWTP/public works site (mfr claims 88% TSS removal efficiency).
- Cocoa Beach:
  - *Brevard Ave.* "bioretention" project (1,350 ft linear vegetated swale/retention system with 10,800 ft^3 of runoff storage) serving ~ 5 acres of old downtown
  - Curb inlet baskets installed in storm drains
- Satellite Beach:
  - *Wilson Ave.* permeable pavement and exfiltration trench serving 5 acres of residential land
  - *Roosevelt Ave.* baffle box serving almost 20 acres of residential land (TSS removal efficiencies have ranged from 30-80% for <1" storm)
  - *Jackson Ave.* exfiltration trenches serving ~20 acres of mixed res./com. by reducing flood frequency and >50% of annual pollutant loads
  - installation of 30 storm drain traps in finger canal residential areas
  - *Jamaica Blvd.* wet detention ponds (3) serving 201 residential acres



The current priority is the completion of the master surface water management plans for Canaveral, Cocoa Beach and Satellite Beach. A city that can boast a completed plan along with some level of financial commitment to carry it out, has the greatest potential to leverage substantial external funds from several, non-point source programs (SJRWMD, state, and federal). With respect to SJRWMD and state funding, it is important for the local governments to include in their plans practical project designs that can effectively meet provisional or final PLRG allocations assigned to their watersheds. The SJRWMD assists local governments in setting pollutant reduction targets and reviewing project designs intended to help meet those targets.

Brevard County is responsible for surface water management on Merritt Island. The county developed a drainage treatment plan for the area and has proceeded with many construction projects called for in the plan. The SJRWMD cost-shared with the county on one of the larger projects in the basin, the Merritt Island airport detention pond, designed to handle and treat runoff from a 190-acre residential basin (see first project described in Table 4-2).

Non-point Source Strategy – Muck. The 1989/90 muck survey (Trefry et al., 1990) included the reconnaissance of the central and southern segments of Banana River Lagoon (segments BR3-7). The northern area (BR1-2 segment) of the lagoon was not surveyed; it is federally managed with minimal development and was presumed to be essentially free of muck (confirmed by observations of other investigators doing work in the area). Banana River Lagoon's muck deposits are thickest and most extensive in its most southern reach (BR7 segment) south of the Pineda Causeway bridge (S.R. 404). This southern reach contains muck throughout its many miles of barrier island finger canals (Satellite Beach and South Patrick Shores) and in its main navigational channels from just north of Pineda Causeway to Dragon Point, the southernmost tip of Merritt Island.

Satellite Beach has taken an active interest in removing muck from its residential canals and controlling its sources of input. The SJRWMD supports this interest and has included this area in its ranking of probable sites for future muck removal. It is possible that muck deposits in this segment are exacerbating water column suspended solid and phytoplankton concentrations (via re-suspension and nutrient flux processes). Therefore, the removal of muck and the reduction of suspended matter loading are considered important restoration measures in this segment.

A feasibility study of muck removal from the canals and other bottom areas in southern Banana River Lagoon was conducted in 1999/2000 (BCI Engineers and Scientists, Inc., 2000). The study concluded that the limiting factor is open land area; at least enough land area needed to economically de-water and produce dry, "truckable" dredge material. A schedule of several years may be necessary to complete the dredge operation given the following: 1) the tens of miles of residential canal and navigational channel and the volume of material to be dredged (~1 million cubic yards), 2) a de-watering operation confined to a limited area locally or to an area many miles away, and 3) the long distances to haul material to various disposal or beneficial use sites.

Non-point Source Strategy – Septic Tanks (a.k.a. OSDS). During the initial 5 years of the SWIM program, the SJRWMD contracted with Brevard County to conduct inspections of septic tanks or OSDS (on-site disposal systems) in areas that were known to have documented failures. The County also performed a survey of all OSDS areas to determine their potential to contaminate surface waters (White and Wiggins, 1995; in compliance with the IRL "No Discharge" Protection Act). In the Banana River Lagoon basin, OSDS use was prevalent on southern Merritt Island, but not on the barrier island where centralized WWTPs are used. The inspections confirmed problems with OSDS use in the Newfound Harbor area. The County then moved rapidly to provide centralized WWTP service to many homes in that area.

Most of the OSDS that remain in use today are found on Horti Point, the eastern peninsula that separates Newfound Harbor from the Banana River Lagoon. Collectively, these OSDS pose a comparatively low pollution risk when considering the collective magnitude of non-point sources. Additionally, the County's general survey found that OSDS areas in the Banana River Lagoon basin pose a low to moderate surface water contamination risk (White and Wiggins, 1995).

Consequently, the OSDS issue is a low management priority in the Banana River Lagoon basin. It is most important in this basin to focus resources on managing surface water drainage. Nonetheless, the SJRWMD encourages County expansion of centralized WWTP service to any remaining OSDS areas.

Point Source Strategy – Domestic Wastewater Treatment Plants. The cities and Brevard County have achieved remarkable reductions in pollutant loading from domestic WWTPs to the Banana River Lagoon. For instance, WWTP loadings of nitrogen and phosphorus to the Banana River Lagoon have decreased by an order of magnitude since 1986 (SJRWMD and SFWMD, 1987). Currently (1996 – 1999), WWTP contributions of TN (14,800 lb/yr), TP (2,850 lb/yr), and TSS (7,100 lb/yr) represent <5% of the total surface water loading of nutrients and <17% of the total TSS loading to the Banana River Lagoon (Figure 4-5). The City of Cape Canaveral WWTP discharges the majority of the point source loadings, which is expected to decrease as plant upgrades and reuse expansion progress.

Like OSDS, domestic WWTPs appear to be a minor source of pollution thanks to local government action in response to the IRL "No Discharge" Act (Chapter 90-262, Laws of Florida). Most of the attention paid to pollution abatement can now be turned to the volume reduction and treatment of surface water drainage.

Monitoring, Modeling, and Applied Studies. The SJRWMD and NASA (via Dynamac, Inc.) will continue the seagrass and water quality monitoring in Banana River Lagoon as part of the Lagoon-wide networks (as described in Chapter 2, pp. 2-15 and 2-16). The SJRWMD will also evaluate and refine the monitoring network in Banana River Lagoon to strengthen empirical relationships among water quality, light, and the depth coverage of seagrass. Analyses and biennial reporting of monitoring data will key in on those major optical pollutants that are significant in this lagoon.

Data from both the water quality and seagrass monitoring networks were invaluable in the calibration of the Pollutant Load Reduction (PLR) Model, which will be applied toward the development of final PLRGs. PLRGs, expressed as both "allowable" loading rates and reduction levels for a lagoon segment, will be allocated among the drainage basins associated with that segment. For example, a TSS PLRG established for segment BR7, the southern Banana River Lagoon, would need to be allocated among its contributing urban drainage basins: Satellite Beach/South Patrick Shores, Indian Harbor Beach, and the southern tip of Merritt Island.

Each local government that is responsible for drainage in these sub-basins would be made aware of its assigned allocation of the total load reduction and would hopefully strive to meet it through their drainage management plans. As stated above (in *Non-point Source Strategy – Surface Water Drainage*), the SJRWMD is willing to participate in a cooperative venture to implement such plans as long as they adequately address either provisional or final PLRGs.

Provisional pollutant load reduction targets are based on estimated 1943 loading rates (i.e., provisional "allowable" or desirable loading rates) and can be used in surface water